Photon Counting & the Statistics of Light

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Abstract

ABSTRACT HERE

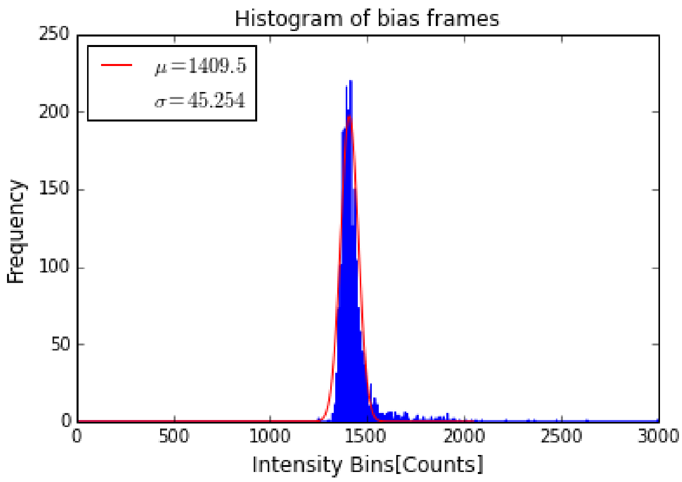

Figure 1: We took a dataset of 1s integration time bias frames by placing the red cap on the spectrometer and in a black bag. A histogram of dark counts is fitted to a Gaussian. The variance of the distribution relates to the read noise and gain of the spectrometer (Howell, 2006).

1. Introduction

is a result of each CCD pixel's different sensitivity to photon

2. Systematic Effects

2.1. Natural Broadening Effect

As seen in Fig. (LABEL HERE) the spectral lines are not perfect sharp Dirac Delta functions. This broadening is due to several physical phenomena, one reason is the natural line width caused by the measurement uncertainty inherent from quantum mechanics. Another more dominant effect is due to Doppler shift from the thermal velocity of the atoms. The distribution of the atomic thermal velocity is governed by the Boltzmann distribution. This Doppler-shifted velocity distribution propagates to our intensity measurement, which can then be rearranged into a Gaussian form. The broadening effect is chracterized by the variance of this new distribution as shown in Eq. 1,

$$\sigma_f = \sqrt{\frac{kT}{mc^2}} f_0 \tag{1}$$

where T is the temperature, m is the mass of the atom, f_0 is the frequency when atom is stationary, c is the speed of light and k is the Boltzman factor.

2.2. Dark Counts

3. Conclusion

Possible extension to this project may be to try conducting a basic flat-field correction to the detector. One way to do this to shine bright light uniformly on the detector to see the response of each pixel. The exposure time needs to be short so that the CCD is not saturated. We can also try to measure maximum ranges at which CCD is sensitive and linear.

References

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